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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

STEAM POWER
PLANT
AUXILIARIES

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Steam Power Plant Auxiliaries

POWER PLANT auxiliaries are power driven units. Individually, they may be temperamental as they may present lubrication problems due to operating conditions such as temperature or lubricant contamination. Collectively, they must work as a team because their operation must be coordinated if maximum efficiency of the plant is to be developed. This means that

a–The conditions which may affect lubrication must be studied.

b–Lubricants should be selected to meet these conditions, and

c–The machines kept up so that the lubricants will give most positive protection to the various gears, chains and bearing surfaces.

Power plant auxiliaries are conventional machines. In appearance they haven't changed much over the years, although in certain phases of design they have gone modernistic with regard to antifriction bearings, protective gear and chain housings and methods for automatic lubrication. These features have led to more dependable lubrication and markedly decreased the cost of maintenance.

> **LUBRICATION of steam power plant auxiliaries can be studied according to the type of lubricating system employed. Inasmuch as the latter is basic, so to speak, and very often applied to more than one type of machine in the plant, the choice of lubricants is simplified and the number of required lubricants is reduced. Usually, it is advantageous to use the power generating equipment lubricants wherever practicable. This is obvious inasmuch as the same steam conditions prevail; so, a cylinder oil suitable for the main engines or pumps is applicable to the steam driven auxiliaries. Likewise, the turbine oil used for turbogenerator bearings is excellent on ring-oiled motor and blower bearings.**
>
> **More specialized lubrication, however, is involved in worm gear lubrication on stoker or pulverizer drives, or in air compressor cylinder lubrication. They must be approached with due consideration of the temperature conditions and the abrasive effects should coal or ash dust work into the operating mechanisms. In fact, the operating conditions generally are the cause of lubrication problems. Modern power plant machinery is designed to permit of effective lubrication provided the lubricant is adaptable to the parts to be lubricated.**

Discussion of the adjuncts to lubrication will be of interest, as they pertain to

Automatic Stokers
Coal Pulverizers
Fuel Oil Pumps
Feed Water Pumps
Coal and Ash Handling Equipment
Economizers
Speed Reducers
Boiler Tube Cleaners
Air Compressors and
Electric Motors, Fans and Blowers

WHAT THEY DO

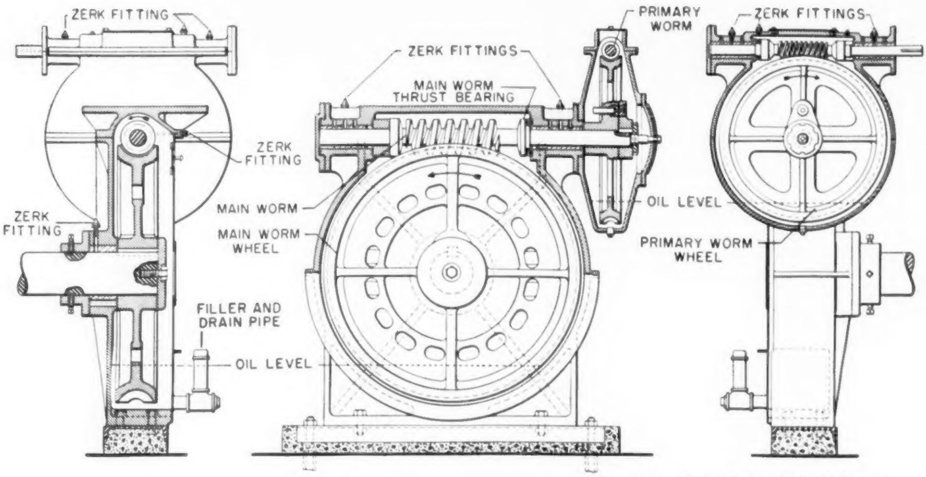
To realize the respective parts that the various auxiliaries play in modern power plant generation of steam and the conversion of heat to electrical energy, it is well to review the structural and operating features. Quite naturally, their usage depends on the type of fuel being used.

AUTOMATIC COAL FIRING MACHINERY

The purpose of automatic coal firing machinery is two-fold, i.e.

a – To decrease the cost of handling and stoking, and

b – To increase the rate of evaporation and indirectly the steam generating efficiency.



Courtesy of The Babcock & Wilcox Co.

Figure 1 — Drive mechanism details (showing lubrication) for the B & W chain grate stoker.

From an economic viewpoint the ultimate result should be a decrease in fuel consumption which should react favorably upon all parts of the plant where coal must be handled or stored.

To attain these objectives, it is obvious that all the machinery involved should be capable of operating at high efficiency with low power consumption. Effective lubrication makes this possible, whereby frictional resistance between the bearings and shafting, the gears and the chain links is so reduced that their operation requires the minimum amount of power.

The machinery used in automatic coal firing involves automatic stokers or coal pulverizers. Both function to eliminate manual handling of coal, although the principle of operation and construction are quite different. The stoker, for example, takes coal in varying size from storage and delivers it immediately to the grates. The pulverizer, on the other hand, reduces coal to a comparatively uniform degree of fineness by the pulverizing elements, then it is fired under pressure mixed with a primary conveying air stream. Necessary additional or secondary air for proper combustion may be introduced at the burner level or directly in the furnace zone. No grates are required.

STOKER DESIGN

Mechanical stokers ushered in the age of modern steam power generation. They led to greater economy in firing coal, and certainly reduced the wear and tear on man power which attended hand firing. The modern stoker with the accompanying provisions for automatically charging coal to the feeding mechanism, enables virtual mechanization of the entire coal handling procedure.

According to the principle involved, or the means by which the coal is fired, mechanical stokers are known respectively as

(a) the overfeed spreader type.

(b) the underfeed or

(c) the traveling or chain grate type.

The mechanism of the modern stoker is relatively simple in design, the driving unit being the essential part requiring lubrication. Individual manufacturers, however, employ various adaptations or types of drives according to the operating requirements of their stokers. In studying stoker lubrication, it is necessary to look into the several designs or basic types in use today, inasmuch as lubrication will be materially contingent upon gear and bearing construction, speeds, ambient temperatures and the means provided for applying the lubricants.

Types of Stokers

Over-Feed Spreader Type

The overfeed spreader stoker is distinctive for its simplicity of operation, flexibility in handling varying load and its ability to burn a wide range of coal. This latter is an important feature where caking and coking varieties of coal are involved, because the fuel is burned rapidly anc without agitation. In spreader stoker firing coal is spread by revolving rotor blades operated by a mechanical feeder mechanism at the front of the furnace, or by pistons direct-connected to coal plungers or rams operated by hydraulic power.

Spreader stokers are of four types:

(a) The travelling continuous grate type where the forward movement of the grates discharge ash continually.

(b) The power dumping grate type in which the grates are cleaned periodically by a steam or compressed air actuated piston and power cylinder, the piston being connected through a link bar connected to the grate sections.

(c) The hand operated dumping grate type which otherwise is similar to (b).

(d) The stationary grate type.

Lubrication must be carefully attended to in operating the modern overfeed spreader stoker. There is the worm gear unit (in the worm drive type) which drives the grates in the continuous ash discharge type (a); the speed reduction gear units with chain connections which operate the mechanical coal feed; the bearings which carry the main shaft of the mechanical feeder; and the bearings which support the front and back sprocket shafts over which the grate in (a) travels. High temperatures may present a problem. In addition some coal and ash dust may be present to cause lubricant contamination. To withstand these conditions pressure grease fittings are used on shaft bearings and the gears and chains are well housed.

Hydraulic drive is used to good advantage where it is desirable to supplant worm gear reductions or other mechanical variable speed drives with hydraulic power. This further simplifies the lubrication problem although it presents the need for careful selection of a dependable hydraulic oil.

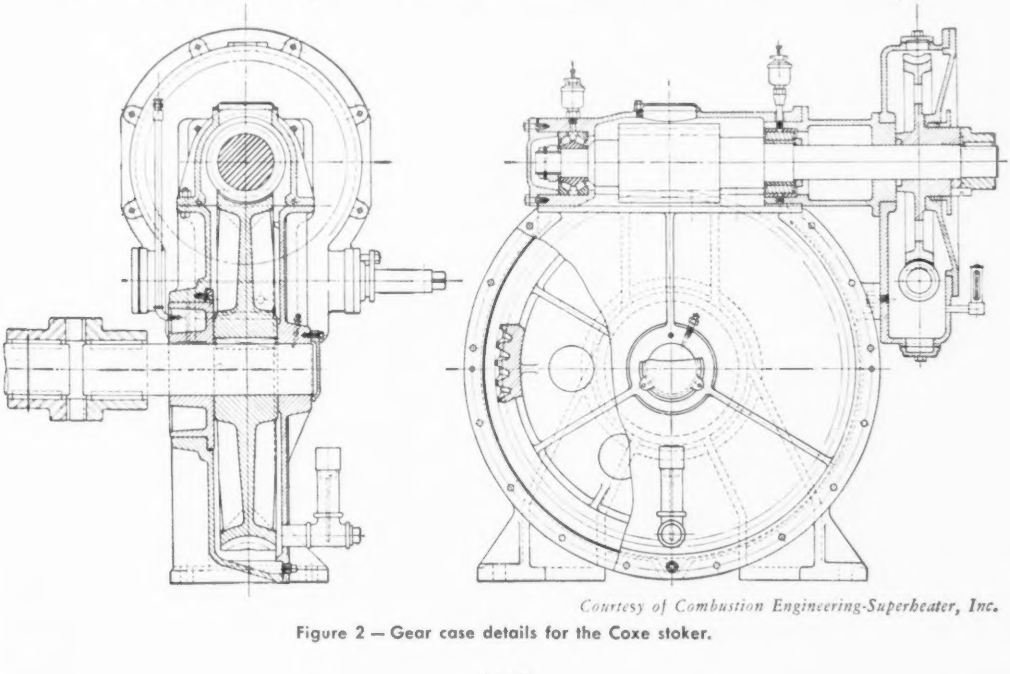
Underfeed Design

Underfeed stokers involve the introduction of fresh coal beneath the fuel bed by means of steam, hydraulic or electric driven rams or plungers. The coal is usually delivered through a gravity feed hopper to the several retorts in which these rams or plungers operate. Essentially these retorts are individual primary combustion chambers, the sides being either stationary or subject to reciprocating motion. These sides also serve to support the tuyeres or air admitting grates, the latter consisting usually of a number of superimposed perforated plates.

As fresh coal is fed into the retort, it is gradually forced underneath the fuel bed by the action of either the main plunger alone or a number of automatic auxiliary distributing pushers or plungers. This movement of the base of the fuel bed, together with the continued air blast which is delivered through the tuyeres, guards against caking or dirty fires. The volatile gases are driven off as the fresh coal becomes hotter and hotter through its proximity to the fuel bed above, being burned as they pass through this heated area; the green coal meanwhile becomes gradually coked, and ultimately burned to ash.

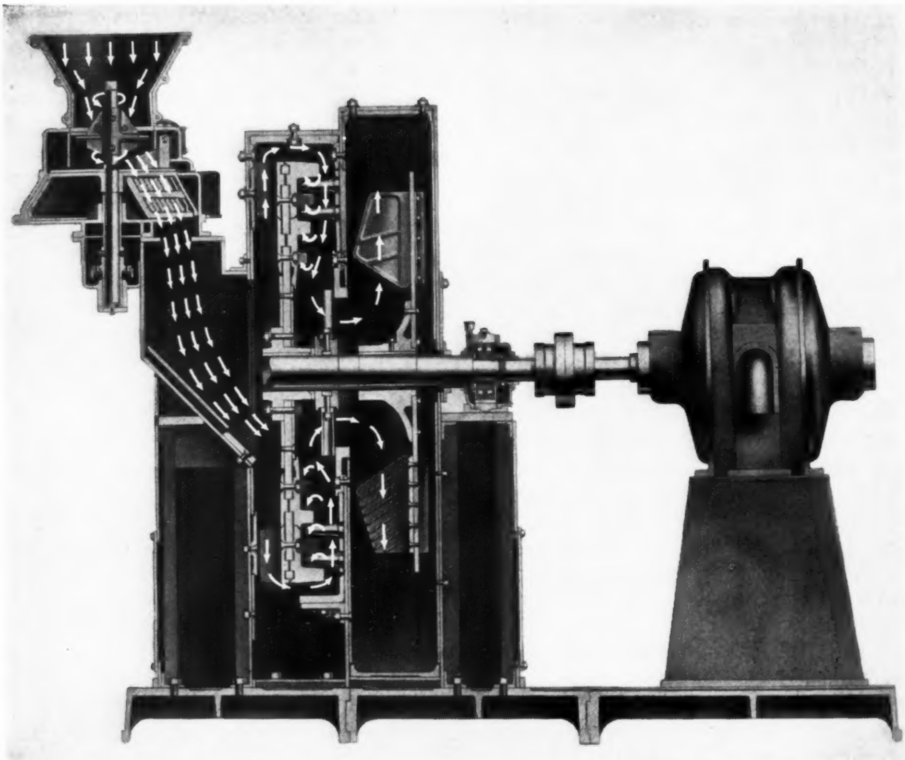
Chain Grate Construction

The chain grate or traveling grate stoker involves an endless chain which passes over suitable sprockets at the front and rear of the furnace, the meshed links of the chain (or bars attached thereto) serving as the grate or fuel bed. This chain is in motion continuously, passing round and round through the furnace, taking fresh fuel at one end of the furnace and discharging the residual ash at the other, as the chain turns over the sprockets.



Courtesy of Combustion Engineering-Superheater, Inc.

Figure 2 — Gear case details for the Coxe stoker.



Courtesy of Riley Stoker Corporation

Figure 3 — Section through the Riley Atrita unit pulverizer.

The necessary number of sprockets are fastened to suitable shafts which are part of the base frame of the stoker. Either the front or rear shaft can be used as the driving element by suitable connection to a worm reduction gear mechanism, which in turn may be driven either by steam or electric power.

Coal is fed by gravity to the chain grate stoker; usually a suitable hopper is installed for this purpose at the front end of the furnace. Practically all air for combustion is delivered through the grate via either one or more distributing compartments below the top grate surface.

PULVERIZER CONSTRUCTION AND OPERATION

The firing of pulverized coal involves the use of either the bin or storage system, or the unit or direct fired system, wherein one to 4 pulverizers are installed per boiler. Both embody the same basic principle, i.e., the pulverization of coal to a sufficient extent to permit of firing in suspension. The unit system in general requires less bulky equipment, and, from the viewpoint of lubrication, at least, is the more simple of the two.

The Unit System

In the unit system the pulverizer is the outstanding piece of equipment from an operating as well as a lubricating point of view. Other equipment involved may include a separator, an exhauster for primary air, a fan for secondary air supply, and the necessary driving motors.

The Bin System

The bin system, in turn, usually involves, in addition to the pulverizer, such machinery as a dryer, dryer fan, conveyor, exhaust fan for use in connection with the pulverizer, a cyclone separator or dust collector, oftentimes an air compressor, coal feeders and blowers and the necessary driving motors. All of these contain bearings which require careful attention to lubrication.

Function of the Pulverizer

The pulverizer requires careful consideration of its lubrication. Essentially a coal pulverizer consists of a horizontal or vertical rotating and pulverizing element, the whole being contained within a suitable housing.

According to the design the pulverizing element or rotor may be constructed to perform its intended

function in one or more stages, frequently being fitted at one end with a suitable fan which forces or induces sufficient air to carry the coal through the system, and to serve as primary air for combustion on entering the furnace. Actual breaking up or pulverization of the coal is accomplished by swing hammers, rings, balls or suitable rolls in conjunction with the crushing surface of the rings or other parts in the housing.

Lubrication Conditions

The pulverizer is frequently subjected to very severe service conditions and, therefore, may involve some decided lubricating problems. Coal dust is continually present, sulfurous impurities (which will tend to react with water to form corrosive acids) may have to be handled, and dampness sometimes prevails. All of these are detriments to operation, in that inadequate lubrication may cause scoring or abrasion of the bearings or gear teeth. The resultant solid or metallic friction can easily cause an increase in power consumption and ultimately the necessity for repair or replacement.

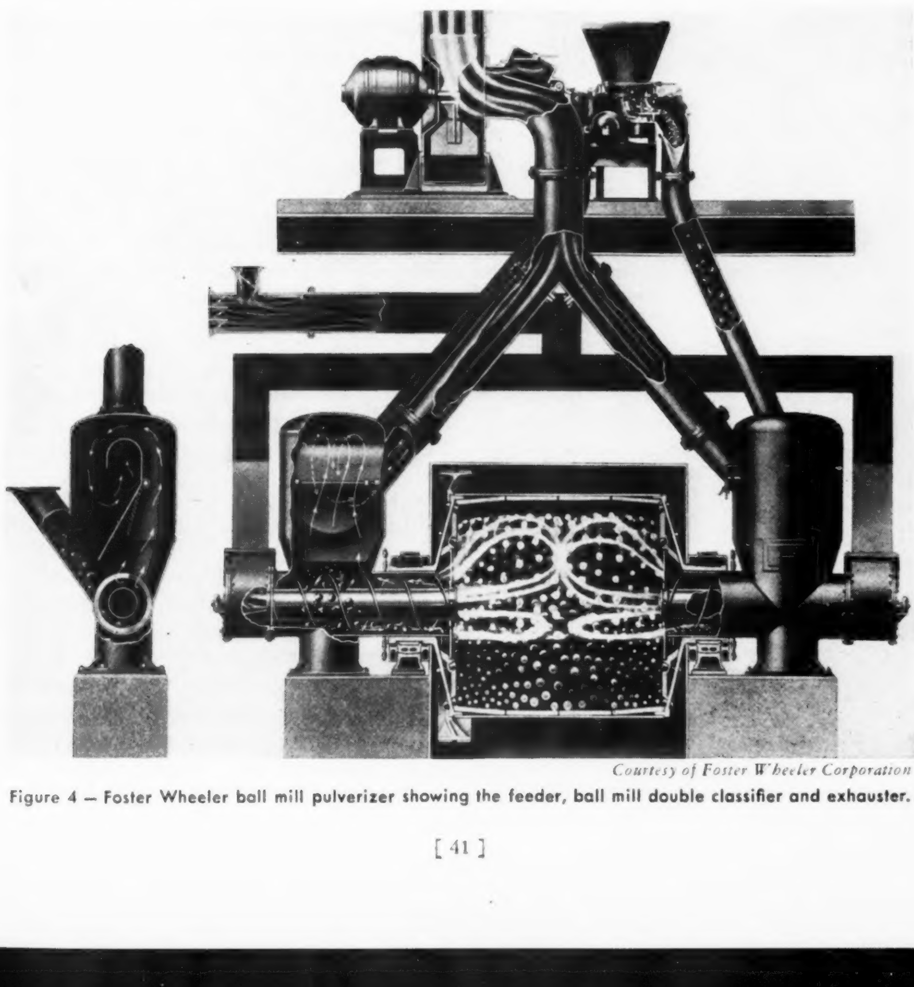
Worm Gears

Design has considered these conditions with the result that pulverizers of the bowl type, for example, are planned as completely as possible for centralized lubrication, i.e. (with the exception of the roller journals) lubrication being maintained from the worm gear housing. This requires the use of a so-called all-purpose lubricant of from 125 to 175 Saybolt Universal Viscosity at 210°F. capable of protecting the sleeve-bearings anti-friction radial and thrust bearings and worm gear drive.

Compounded steam cylinder oils are preferred by many. There are others, however, who would rather use the newer non-corrosive type of lead soap lubricant. This product has the advantage in that it not only gives adequate protection to the worm gears under the prevailing operating conditions, but also it can be used on the roller journals.

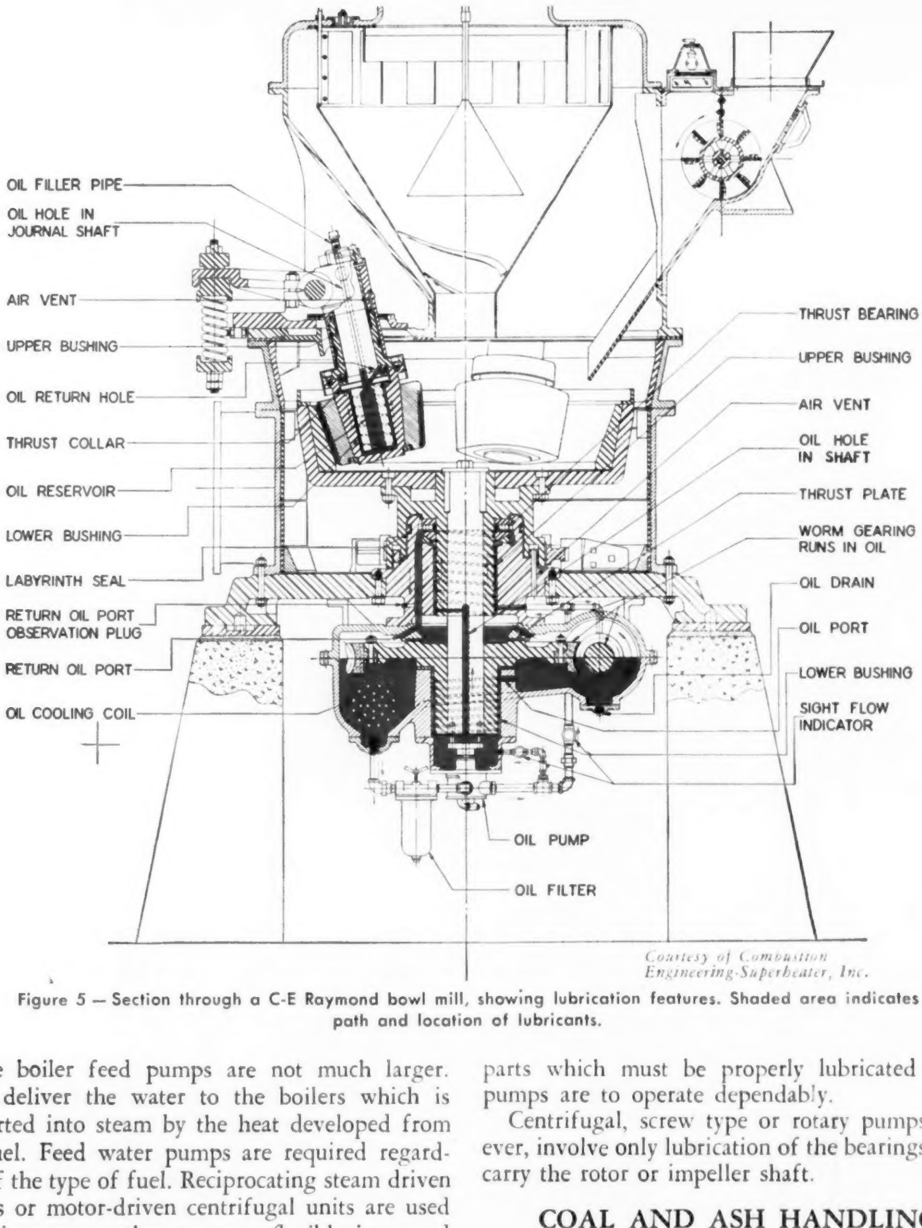
PUMPS

In fuel oil burning plants, pumps are most important; in fact, no pumps, no steam. Fuel oil pumps are not prepossessing units. Tucked away in a corner (often installed in duplicate) a horizontal reciprocating or screw type pump about the size of a car seat will pump enough fuel oil to generate the steam required to run the turbo-generators to serve the power and light needs of several thousand people.



Courtesy of Foster Wheeler Corporation

Figure 4 — Foster Wheeler ball mill pulverizer showing the feeder, ball mill double classifier and exhauster.



Courtesy of Combustion Engineering-Superheater, Inc.

Figure 5 — Section through a C-E Raymond bowl mill, showing lubrication features. Shaded area indicates path and location of lubricants.

The boiler feed pumps are not much larger. They deliver the water to the boilers which is converted into steam by the heat developed from the fuel. Feed water pumps are required regardless of the type of fuel. Reciprocating steam driven pumps or motor-driven centrifugal units are used for this purpose; they are very flexible in regard to speed, pumping capacity and head, and show a relatively uniform efficiency curve under wide variations in these operating conditions.

Reciprocating pumps involve sliding motion between the pistons or plungers and the cylinder walls, the valves and valve seats, and the piston rods and valve stems in contact with their stuffing boxes. When they are electric-driven the speed reduction mechanisms which are usually gears or chain drives also involve contact motion. All are parts which must be properly lubricated if the pumps are to operate dependably.

Centrifugal, screw type or rotary pumps, however, involve only lubrication of the bearings which carry the rotor or impeller shaft.

COAL AND ASH HANDLING

This discussion will deal solely with the coal and ash handling equipment which is located under cover and directly adjacent to the boilers. Overhead storage bins with accessory coal chutes, hoppers and the necessary hoisting equipment increases the amount of machinery in the modern boiler plant which requires lubrication and maintenance.

Coal handling from the main storage yard to the bunkers is accomplished by a bucket or skip hoist for elevating, and by cars, or screw or flight conveyors for horizontal distribution. The skip

hoist is essentially a bucket or larry car designed to travel between guide rails or on tracks, being hoisted from the loading pit to the discharge level above the bunkers by cables and a suitable hoisting mechanism. In the same manner, the skip hoist can be used for handling ashes. Tram rail conveyors and traveling weighing larries which are used for handling coal in the boiler house are quite similar to cranes in design and method of operation. Like the skip hoist, they deliver the coal at periodic intervals according to boiler requirements.

Ashes, in turn, are handled by means of gravity, pneumatic pressure, traveling conveyors or larries. Gravity is the most economical where it can be used, furthermore it reduces the amount of equipment to be lubricated for the necessary chutes and hoppers are rugged, and with the exception of the gates there are no parts to be lubricated. Ash gates, however, must be carefully considered as they are subject to severe service and their moving parts are close to the ashes and usually exposed to high temperatures even though the ashes have been quenched.

In general, ash gates are of the pivoted or roller type. Power control by means of steam, air or hydraulic power is advantageous especially in large plants. Steam or air cylinder lubrication is a factor in the power operated gate. In general, the steam cylinder or air compressor oils used elsewhere in the plant are applicable. Mechanical force feed lubricators or oil cups are used. The amount of oil being delivered to the steam or air should be about the same as would be fed to the cylinders of the steam pumps or air cylinders elsewhere in the plant.

Pivot bearings which carry the pins in pivot type gates and the rollers which support the gates in roller installations are generally pressure grease lubricated, the grease serving both as a lubricant and as a seal to prevent abrasive ash dust from working into the clearance spaces.

ECONOMIZERS

An economizer makes use of the heat contained in the flue gases after they have left the boiler, for the purpose of heating the boiler feed water. The design involves a nest of tubes built with inlet and outlet headers, located in the uptake or flue between the boiler and stack. As the feed water is circulated through this equipment it takes up heat from the flue gases.

SPEED REDUCERS

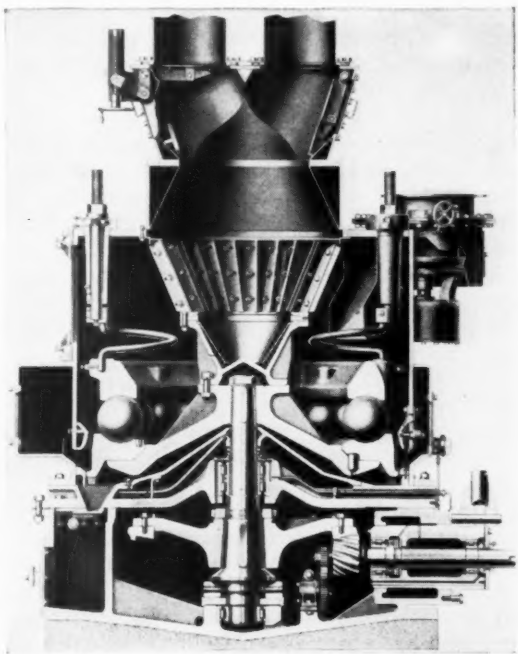
Stoker drives and some of the other auxiliaries require worm gears or other types of speed reducers. Worm gear installations in the power plant require careful attention. Stoker drives may manipulate the grates, operate the plungers and rams, or run the chain grate and turn the clinker grinder, according to the type of stoker.

According to the make of stoker, when worm drives are employed the worm is located either above or below the gear. Lubrication must be studied accordingly. Stokers normally run at low speeds due to the gradual rate at which the coal is fed. As a result, large speed reductions are employed especially when the driving unit is a motor or auxiliary steam turbine.

Obviously, the selection of the lubricant for a stoker worm drive should be based upon the type of gear case installed. An oil-tight casing will enable the use of bath lubrication by a lubricant of steam cylinder oil viscosity, i.e. from 150 to 175 Seconds Saybolt Universal at 210 degrees Fahr. On exposed gears or those not so tightly enclosed, a heavier lubricant is required.

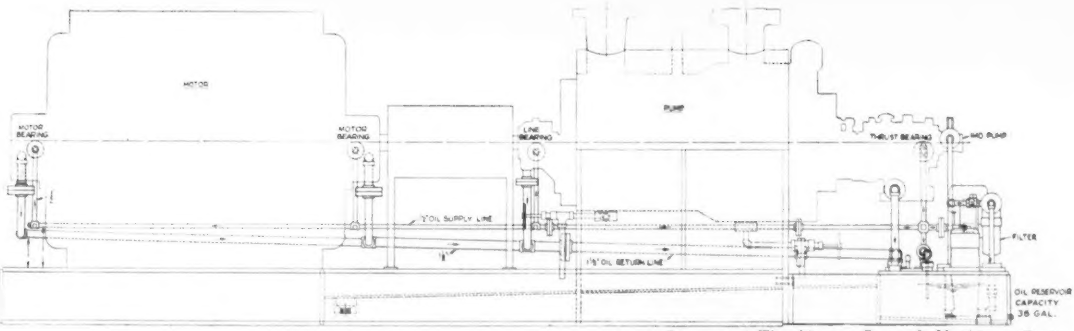
TUBE CLEANERS

Boiler tubes can become fouled or encrusted on the water sides especially if hard water is used. During the process of steam generation, the non-soluble sulfates and carbonates "plate out" or scale on the tube surfaces. Water softening devices are designed to prevent or retard this, but even so, a tube cleaning procedure is necessary at certain intervals to prevent tube burning. Cleaning is done by means of a tube cleaner, a device which can be run through the tubes to bring about scale removal and soot accumulations by cutting (inner scale) or by rapid and continuous vibration of a vibrator or hammer which strikes the tube walls at a frequency



Courtesy of The Babcock & Wilcox Co.

Figure 6 — Details of the B & W type E pulverizer.



Courtesy of Worthington Pump & Machinery Corp.

Figure 7 — Side elevation of the oil piping layout for a Worthington boiler feed pump.

according to the pressure. Scale is most effectively removed when the hammer strikes against bare or clean walls. Impact against scale or soot encrusted surfaces reduces the vibration effect.

Tube cleaners are operated by hydraulic, steam or air pressure. A rotor or wheel in the rotary or turbine type of cleaner enables the direct pressure of water, steam or air to develop the required rotary motion at the cutting tool. The vibratory type of cleaner, which uses steam or air pressure, operates on the principle of the reciprocating steam engine, a piston being involved which is in contact with the freely moving vibrator which has its fulcrum within the device to the rear of the piston. The latter develops the desired vibratory motion at the vibrator or hammer head.

The moving parts of the vibratory cleaner are more intricate than those of the rotary device, accordingly their lubrication must be effective and continuous during operation. Normally, this is effected by lubricating the steam or air as in an engine or compressor. The ball and socket, however, is oiled by hand at the hammer end, about a teaspoonful of oil being squirted in every ten or fifteen minutes. Unless these parts are kept well oiled they will wear rapidly.

Rotary or turbine tube cleaners require maintenance of an adequate film of oil between the rapidly rotating shaft of the rotor and its supporting bearings. This is accomplished by oiling the steam or air as in a vibratory cleaner.

The type of oil to use in either case must be selected according to whether the cleaner is air or steam operated. A pneumatic cleaner requires a good grade of compressor oil of around 200 Seconds Saybolt Universal Viscosity at 100 degrees Fahr. In the steam driven cleaner the compounded steam cylinder as used on the steam pumps will function, the compound being necessary to emulsify with the moisture which is usually present in the steam.

AIR COMPRESSORS

Air compressors are required in the boiler plant when air powered tube cleaners or other applications of compressed air is necessary. In an industrial installation the compressor capacity may also be used elsewhere in the plant. The compressors, however, are conventional, as a rule, being either steam driven horizontal reciprocating units or motor driven rotary machines. Lubrication of the air side is of concern inasmuch as it will require selection of a compressor oil suited to the air pressure developed, the possibility of moisture in the air and the type of compressor.

MOTORS, FANS AND BLOWERS

Motors keep the plant running. In an electrified plant they can be used to drive all of the other auxiliaries by electric power. Motor power is one of the "stream line" developments in modern power plant design as it obviates the need for auxiliary steam piping and helps to achieve a better heat balance between the boilers and power generating machinery.

In view of the reliance which is placed upon the motors, their bearings must be lubricated effectively. This also holds true for the fans and blowers which develop the forced draft required in the boiler room. Bearing design and lubrication, therefore, is treated in detail later.

THE PARTS TO BE LUBRICATED BY CYLINDER OIL

Steam driven boiler feed or fuel oil pumps, compressors or auxiliary generators require steam cylinder oil for lubrication of the steam sides of the machines.

A steam cylinder oil must lubricate every sliding surface which is either in direct contact with the steam or subject to its pressure and temperature. In other words, the valves, valve rods, valve stems, valve seats, cylinder walls, pistons and piston rods—all are not subject to the same pressures and temperatures, yet the one oil must serve throughout; it must therefore be able to develop effective lubrication at all times.

How Cylinder Oil Is Applied

Steam cylinder oils are applied by:

1. Direct feed to the moving parts, or
2. "Oiling the steam" by delivery of the oil into the steam line so that the steam atomizes it and carries it to all moving parts within the valve chest and cylinder.

When steam cylinder oils are applied by means of individual oilers installed on the valve chest and cylinder, the lubricant is fed in drop by drop being spread over the contact surfaces by the movement of the valve and piston.

When steam cylinders are lubricated by injecting oil into the steam line, the oil is atomized and distributed by the steam which acts as a carrier. A hydrostatic or mechanical force feed lubricator used for this purpose is dependable and conducive to most effective lubrication when sufficient oil is fed to the steam line, and the point of introduction of the lubricant is located a few feet back of the throttle valve and steam chest so that the atomizing effect of the steam can be fully utilized.

Complete atomization is the secret of steam cylinder lubrication. If any of the oil is carried into the cylinder in liquid state, its lubricating effect may be lost, as it will probably be swept out prematurely by the rush of exhaust steam before it can distribute itself uniformly over the contact surfaces.

If the point of lubrication is located too close to the throttle valve or cylinder, complete atomization may not take place; if too far away there will be possibility of the oil particles being thrown to the walls of the steam line, then flow of liquid lubricant will occur to the valve chest. This "condensation" of the oil may be quite considerable if there are any bends or other pipe fittings located between the lubricator and the valve chest.

The actual composition of a cylinder oil is governed by the amount of moisture in the steam. Moisture will usually cause a film of straight mineral lubricating oil to be washed off from the cylinder walls and other surfaces with which the steam comes in contact. To secure proper lubrication under wet steam conditions an oil which contains a certain percentage of fatty compound such as lard oil, degras or tallow should be used.

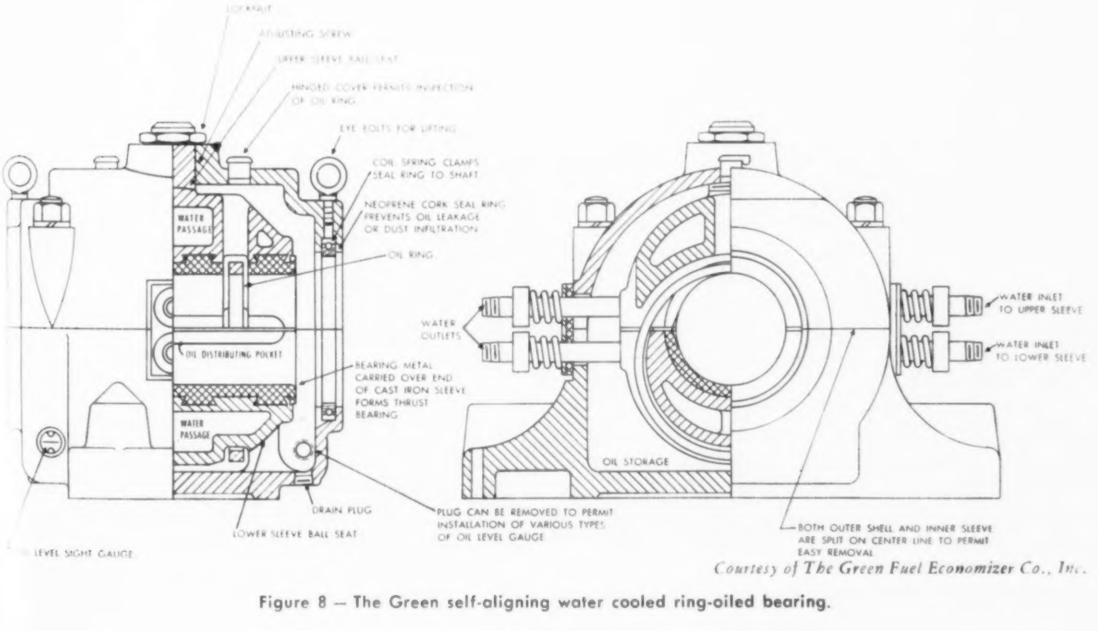
Compounding develops an emulsion when the oil comes in contact with wet steam. The resultant lubricating film has a greater affinity for the cylinder walls and other wearing surfaces resisting the washing action of the water in the steam. The greater the percentage of moisture in the steam the higher should be the fatty compound content, although in general this should not exceed 10%.

EXTERNAL RECIPROCATING ELEMENTS OF PUMPS AND COMPRESSORS

Bearings, guides and pins of reciprocating engines, compressors, and steam pumps are, in general, lubricated by force feed oilers, splash lubrication, sight feed oil cups, pressure grease fittings or grease cups.

Intermittent Lubrication

Intermittent lubrication is developed by oil cups or grease fittings. Normally they are simple in



Courtesy of The Green Fuel Economizer Co., Inc.

Figure 8 — The Green self-aligning water cooled ring-oiled bearing.

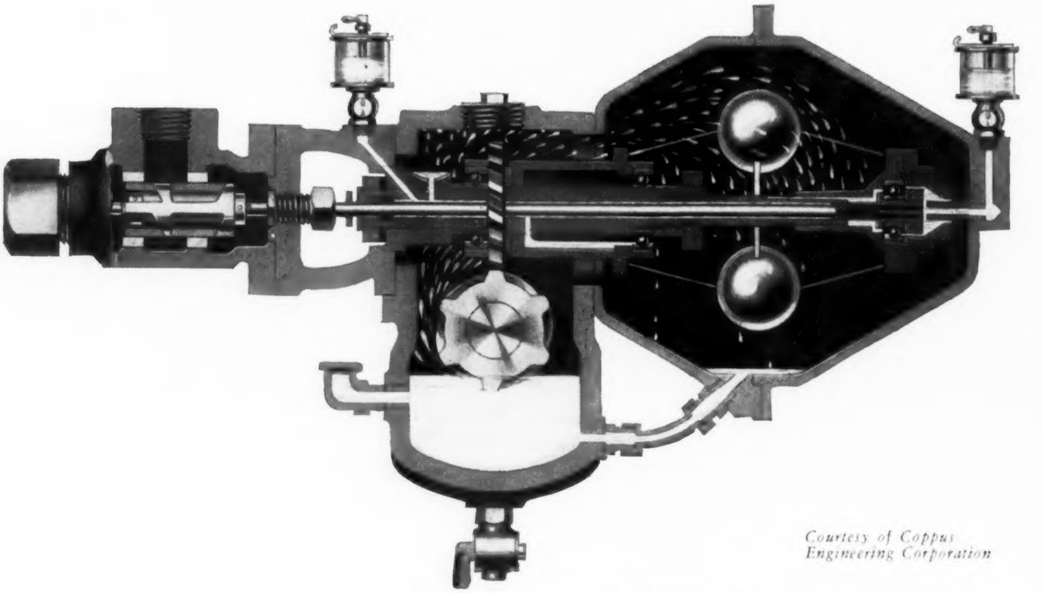


Figure 9 — Sectional view of a Coppus turbine governor showing sight feed oil cups and splash lubrication.

operation and if properly handled they will feed the right amount of lubricant very economically. Sight feed oil cups require a medium to heavy oil which should be selected for its ability to remain on the bearing surfaces for fairly lengthy periods. As a general rule systems of this nature will require an oil of from 300 to 500 seconds Saybolt Universal Viscosity at 100°F.

Continuous Lubrication

In a continuous system the oil acts not only as a lubricant but also as a cooling medium to carry off any frictional heat that may be developed in the bearing under operation. This flood of oil also keeps the bearing surfaces free from dust, dirt and metallic particles, reducing the tendency towards abnormal wear, scoring, etc.

In large plants the oil from a continuous oiling system can be drained to some central point of collection from which it may be removed when desired for reconditioning.

This procedure is advisable periodically, or else a fresh charge of oil should be used, as the oil is subjected to hard service.

Splash System

The essential idea in splash lubrication is to maintain a suitable supply of oil in the crankcase in order that the crank or its oil dipper will never miss the surface of the oil.

Splash lubrication is adaptable to vertical engines or compressors where the crankcase is completely enclosed and the entire system oil tight. Splash systems often have some provision attached to the crank for picking up the oil from the reservoir and transmitting or throwing it to the bearings and guides.

Oils used for splash lubrication should separate rapidly from water and sediment. The lower the viscosity (consistent with requirements), the more rapid the separation.

Force Feed Lubrication

In a force feed system the oil is pumped to the bearings at pressures ranging from 5 to 15 lbs. per square inch. The operating and constructional conditions will influence the type of oil which should be used. When the system is of ample purifying and circulating capacity the oil will be subject to comparatively light duty, inasmuch as bearings are continually washed out and there is opportunity for dirt and water to precipitate. Also as there is an adequate and continuous flow of lubricant it will be generally unnecessary in such a case to select an oil capable of standing extreme temperatures or loads. The lighter the oil the lower will be its internal friction. A straight mineral oil of from 150 to 200 seconds Saybolt Universal Viscosity at 100°F. will usually be satisfactory for such service. It should not emulsify nor contain any corrosive acids. Emulsification would clog the system, while acids would cause deterioration of the piping, filters, settling tanks, bearings, etc.

ROTARY EQUIPMENT

In this classification can be grouped the motors, centrifugal pumps, fans, blowers and coal pulverizers in which bearings constitute the principal or only frictional parts requiring lubrication. The

lubricant, of course, must be selected according to the type of bearing, the temperature, the seal design and the means provided for re-lubrication. Ring oiled sleeve bearings or anti-friction bearings predominate. Their lubricating requirements quite naturally are based on their construction as well as the location with respect to the boiler plant. Obviously a motor operating a stoker would be exposed to higher surrounding temperatures than a fan motor in the chief's office.

Ring Oilers

The ring oiler involves a bearing housing which is built with an oil reservoir in the base and a slot of sufficient width and depth to permit one or more rings to revolve therein. Turning of the shaft causes the ring to turn, to result in a certain amount of oil being carried to the top of the shaft. From here it flows into the bearing oil grooves and clearance space, ultimately to be distributed over the entire contact surfaces. The extent to which a ring dips will depend upon the level at which the oil is carried. It is practicable to control this by installing a suitable sight gage and overflow.

The oil after being passed through the bearing clearance, should be able to flow to the end or ends of the shaft and back to the oil reservoir below, through a suitable return chamber which is part of the bearing housing.

Ring oiling affords a most efficient method of lubrication whereby the bearings are flooded with a considerable excess of oil over the amount that would theoretically be necessary to furnish the requisite oil film. By flooding a bearing with oil, the latter serves not only as a lubricant and flushing agent but also as a cooling medium to carry away part of the frictional heat developed, thereby reducing the temperature of operation.

Effective lubrication is assured if the reservoir is of adequate capacity to give the oil ample opportunity to rest, and allow sediment and other foreign matter to settle out; this also promotes cooling.

As the washing action of the oil often will cause the reservoir gradually to accumulate a certain amount of sedimentary deposit, it should be flushed out and cleaned at periodic intervals, the old oil being replaced with a fresh charge.

Oil Characteristics

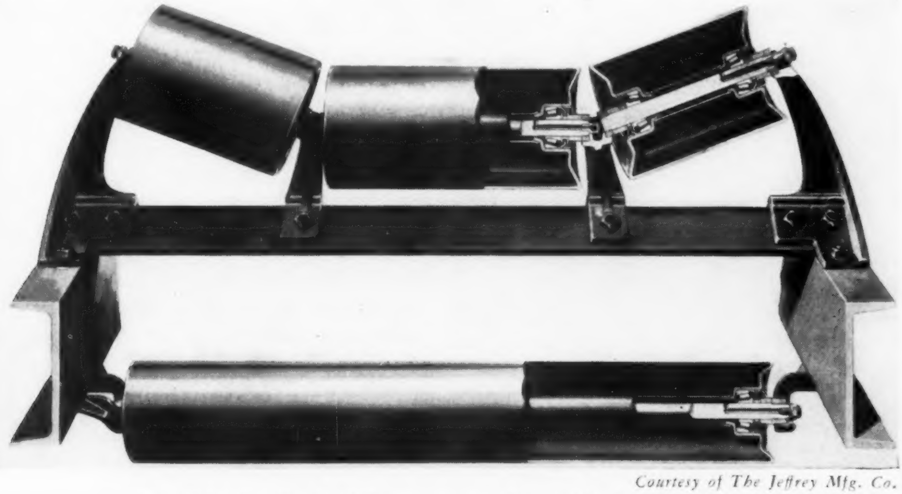
Ring oilers on power plant equipment usually will require a high grade straight mineral oil of from 150 to 300 Seconds Saybolt Universal Viscosity at 100°F. In view of the small volume of oil involved some plant personnel find it most economical to use their turbine oil for this purpose, and avoid stocking a bearing oil of comparable viscosity. In determining upon the viscosity of such an oil, the operating temperatures should be considered. The bearing construction also should be investigated; oftentimes, if oil returns are too small they may become clogged, causing heavier oils to overflow.

Should certain of the equipment have to function at times under abnormally low temperatures, (for example a fan under the roof in winter), an oil with a low pour test should be chosen. If this latter approximates zero degrees Fahr., the oil will generally function satisfactorily.

Conversely, higher temperatures (around the boilers) will oftentimes require additional viscosity to resist the thinning down action of heat. Under such conditions, an oil of from 400 to 500 seconds viscosity or even higher may be advisable.

Anti-Friction Bearings

Ball or roller bearings permit of measured lubri-



Courtesy of The Jeffrey Mfg. Co.

Figure 10 – Details of a Jeffrey conveyor roll assembly showing bearings.

Courtesy of Westinghouse Electric Corporation, Sturtevant Div.
Figure 11 — Details of a Sturtevant self-aligning water cooled fan bearing.

cation from the viewpoint of the capacity of the bearing for lubricant. Either grease or oil is used according to the type of bearing, its service and the manner of sealing. The customary housing design affords excellent protection against the entry of contaminating foreign matter; it also facilitates controlled lubrication within the limits prescribed by the manufacturers.

Anti-friction bearings involve rolling contact as compared with plain bearings wherein sliding contact occurs. Lubrication facilitates this rolling action. To enable this, however, all the surfaces (which are of a highly polished nature) must be in as perfect condition as practicable. The lubricant must therefore serve the dual purpose of both lubricating, and protecting these surfaces against rusting, corrosion, pitting or abnormal wear.

Minimum clearance, of course, is an aid to proper functioning of such bearings, for the occurrence of any play between the component parts would tend to set up a certain amount of vibration which would be detrimental to effective operation, as well as the bearing parts.

Oil Viscosity

Where oil is required it should be a highly refined product, of a viscosity commensurate with the bearing size, temperatures, speed, and pressure, involved. In power plant service oil with a viscosity of from 100 to 200 seconds Saybolt Universal at 100°F. usually will be applicable.

The oil level in a ball or roller bearing is important. Too much oil may cause abnormal internal friction to occur within itself. Bearing designers feel that submergence of approximately one-half or three-quarters of the lowest rolling element gives best results. Contrary to the principles of plain bearing lubrication, the oil in a ball or roller bearing plays no part as a coolant. Volume, therefore, can be a detriment rather than an advantage.

Where end thrust may develop to an appreciable extent, especially in roller bearings, or, where pressures or temperatures may be high, certain authorities feel that better lubrication will result if somewhat heavier oils are used. Under such conditions, products as high as 750 seconds Saybolt Universal Viscosity at 100°F. are advocated. Even mineral cylinder oils of a high degree of purity may be necessary on machines subjected to extremely high duty, pressure or temperature. The selection of heavier oils for roller bearing lubrication, however, should be done with the utmost care for it is very possible to over-estimate the conditions of operation with the result that an excess of internal friction may be developed.

Grease Lubrication

Grease is applied if oil leakage would be a detriment or under conditions of dust, dirt or dampness. Greases furnish better seals against the entry of dust, dirt and moisture thereby serving to protect the polished surfaces of the bearing elements most effectually. Greases also can be more easily retained in a non-oil-tight housing; on the other hand, dirt or grit that finds its way into a grease lubricated bearing, does not settle out, consequently, it is worked between the bearing parts to exert an abrasive action. Dust seals or guards, therefore, are a requisite in dusty locations. Obviously they must be properly maintained.

A grease of N.L.G.I.*, No. 2 Classification Grade will meet average operating conditions where the lubricant must readily cover the entire surfaces of the balls or rollers and not tend to channel in the housings or raceways. If extra high temperatures prevail, it might be necessary to choose a grease specially prepared to withstand the thinning out effects of heat, and prevent the consequent entry of dust, dirt, or other contaminating foreign matter. Greases of the same type also are usable in pressure gun fittings on sleeve bearings.

CONCLUSION

The law of supply and demand can be aptly applied to the steam power plant. The supply of fuel and air must meet the demand for steam and power. Output is rated on an efficiency basis, according to the rate of evaporation. Greatest economy in steam output is developed when the plant functions as a coordinated unit. This article is intended to indicate how lubrication of the auxiliaries is related to the over-all performance of the plant. It is never wise to overlook this fact or to skimp on the grades of lubricants used; the ultimate saving in original cost of oils and greases is too insignificant in contrast with potential power losses in service, or if machinery must be down for repair due to unwise lubrication.

*National Lubricating Grease Institute

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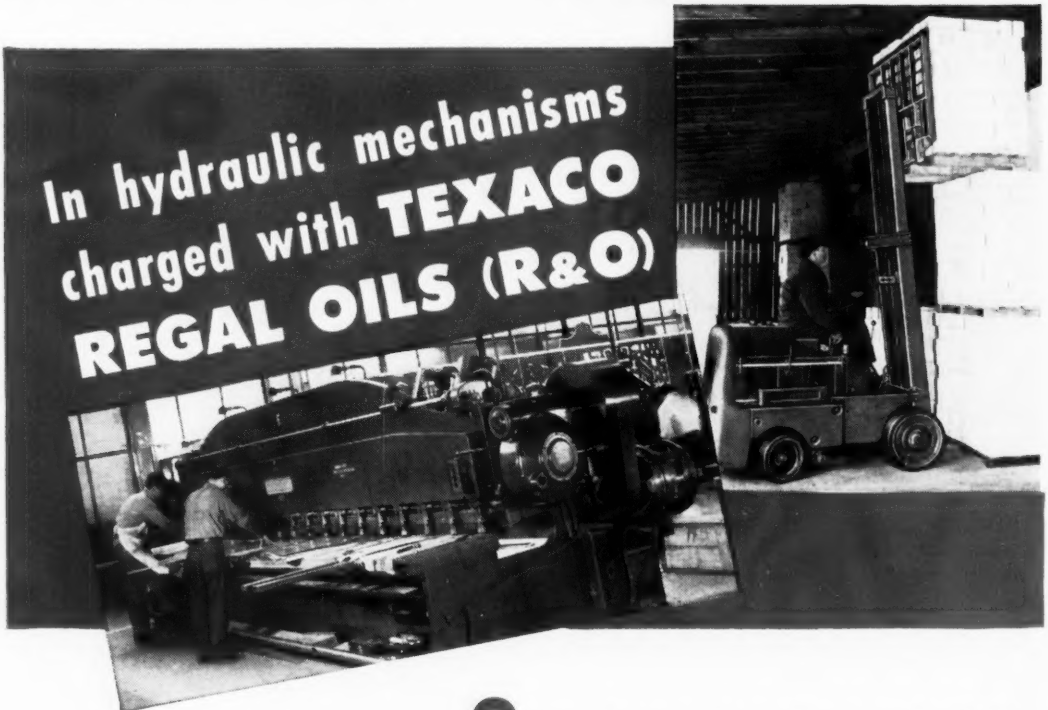

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